Red Tart Cherry Site Inventory

FOR LEELANAU COUNTY MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
EAST LANSING, MICHIGAN

CONTENTS

A FRUIT SITE INVENTORY

A method of identifying and mapping red tart cherry sites was developed in Northwestern Michigan. The basic procedure described here for cherry sites can be adapted to other geographic areas and for other fruit crops with exacting requirements of soil, topography, and climate.

Objective

The objective of the red tart cherry site inventory is to evaluate a parcel of land in a given location according to its capability to consistently produce cherry crops. Such an inventory is valuable for determining the location, extent, and quality of available red tart cherry sites.

Areas with the favorable combination of soil and climate for producing red tart cherries are located and evaluated. This type of information is useful in many ways, one of which is protecting these rather limited areas from being despoiled by the pressures for other land uses.

Dependable red tart cherry sites are in demand for other uses. Generally high-lying, they are choice locations for home building. Community planners need to recognize the value of these relatively scarce sites, to set priorities on their use and to give protection, if necessary, to the environmental condition that makes these sites productive. Construction of a building complex or even the raised roadbed of a new highway built across a major air flowageway may change a good, frost-protected site to one that is unsatisfactory for production of red tart cherries.

The site inventory also may help prevent the planting of orchards on unfavorable sites. The grower, the processing industry, and the community suffer as a result of fruit planted on marginal sites. The red tart cherry industry illustrates this problem. It has had a history of feast and famine for many years. The years of high production have usually resulted in low prices. Low production years resulted in higher prices. Generally, the high price years encouraged growers to plant new orchards, many on marginal sites. When these trees come into production, those on marginal sites bear only in years of favorable weather conditions. This increases the already fluctuating production - high in years of favorable weather, very low in others.

Processors and market outlets are dependent on a stable supply of cherries. The cherry processor cannot maintain plant capacity to handle peak production that occurs only 2 or 3 years out of 10. When the market is glutted, prices drop to a level where neither grower nor processor can operate at a profit. In years of low production, only the favorable sites produce a good crop of cherries. Some growers have nothing to sell and the processor has equipment standing idle. The industry is always faced with the problem of furnishing a uniform annual supply in order to attract the consumer to purchase cherries and not a substitute fruit. It is difficult for an industry to maintain its position in the market place with such wide variations in production, caused in part by orchards planted on marginal sites.

A rating system has been developed as a way to inventory red tart cherry sites in order to meet the needs of the growers, processors, community planners, and others.

Inventory's information can:

1. Assist the potential fruit grower in selecting a site for a profitable enterprise.

2. Assist the present fruit grower in reassessing present orchards and in planning future plantings.

3. Assist growers in relocating in a more favorable location or in obtaining a larger economic unit.

Other Uses:

1. Agriculture assessment - to delineate lands that should receive tax consideration if they are to be maintained in agricultural use.

2. Zoning commissions - to delineate potential fruit sites and plan for nonconflicting uses adjacent to fruit areas.

3. Planners of community services - to cause the least amount of fragmentation of ownership.

4. Comprehensive areawide planners - to establish basis for a stable industry.

5. Investors - to evaluate risks in capital investments pointed toward developing fruit-producing areas with a favorable and stable base.

6. Tourists - fruit production increases and enhances the tourism and recreational potential of an areas. Tourists are a by-product of the total fruit industry.

Agencies or groups that might use a fruit site inventory include:

1. Processing groups

2. Banks or credit organizations

3. Nurseries

4. Irrigation and other equipment suppliers

5. Fruit specialists

6. Agricultural research groups

7. Climatologists

8. Resort and recreation groups

9. Zoning and planning boards

10. Real estate sales organizations

RED TART CHERRY SITE INVENTORY
Leelanau County, Michigan

Field work by: Keith R. Martell, Marvin Hansen, Roscoe Barber, Richard Larson, and Guy Springer (all of the Soil Conservation Service) and T. Michael Thomas, County Extension Director, Leelanau County.

Leelanau County is in the northwestern part of the lower peninsula of Michigan (fig. 1). It has a total area of about 349 square miles or 223,330 acres. In 1970, the county had a population of 10,864. Leland, on the shore of Lake Michigan, is the county seat and the access point to the Fox and Manitou Islands. Leland is 235 miles northwest of Detroit, 150 miles north of Grand Rapids, 175 miles north-northwest of Lansing, and 110 miles south-southwest of the Straits of Mackinac.

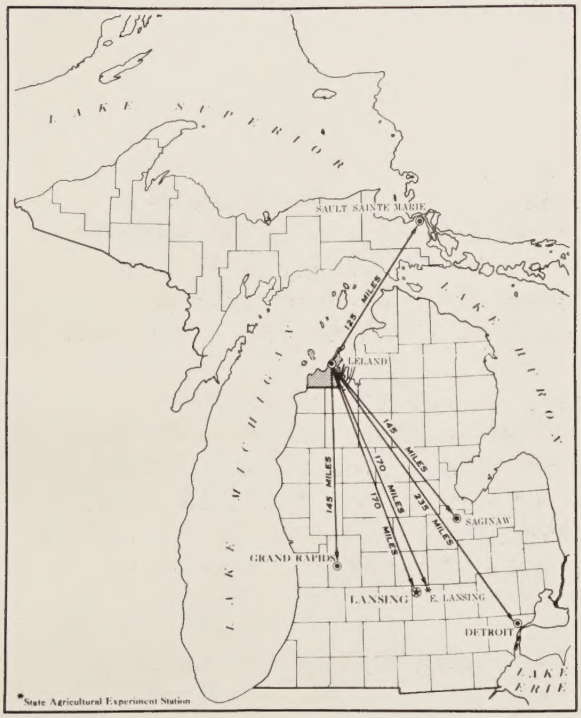

Figure 1 - Location of Leelanau County

Site Requirements for Red Tart Cherries

The Leelanau County inventory was based on the site requirements of the Montmorency red tart cherry. This fruit occupies the most acreage and is economically the most important agricultural crop to the county.

Following are factors which make a desirable red tart cherry site in Leelanau County:

Soil Factors

The most desirable soil is a well drained, sandy loam that is well aerated and has a medium to high natural fertility. The soil must have a moderate available water capacity, a moderate to moderately rapid permeability, and at least 48 inches of depth to permit unrestricted root penetration for good growth and anchorage. Soils having these characteristics will usually respond well to the proper management techniques for growing red tart cherries.

Physiographic Factors

Physiographic features of the site determine to a large extent the microclimate, which in turn influences yield of cherries. Differences of soil, soil cover, elevation, and exposure are responsible for microclimatic variations that are extremely important. The most desirable site would be one on which all effects of local climate are favorable for best production. Slope gradient should be 2 to 12% to permit ease of equipment use and other soil management practices, yet still provide adequate air drainage. Slope should be fairly uniform with well-defined water and air flowageways. There should be no constriction or obstruction to the cold air flowageways. The site should be located so that cold air from adjacent land does not drain over or onto it. Also, it is more desirable to have air drained into a cold air storage basin over water than into a cold air storage basin over land. Orchards should be planted above the principal spring freeze line 1/ of the cold air storage basin. Finally, the general exposure should permit the crop to take full advantage of sunshine yet not be exposed to damaging winds during pollination and fruit bearing.

Climatic Factors

The spring temperature should remain cool to retard fruit bud development and minimize danger of damage due to spring freezes. During the pollination-fertilization period of bloom, temperatures should exceed 50° F in daytime for bee activity and should not drop below 28 to 30° F for any period of time. The site should be as free of fog as possible. Warm sunny days without desiccating winds are important for good pollination and fruit set.

The lowest winter temperatures seldom, if ever, should get as low as -15 to -20° F for tart cherries. An insulating cover of snow can provide for uniform soil temperature, but whether or not this is a significant factor in fruit production is not known. (Sunshine reflected from the snow cover may cause wide and rapid variations of temperature in tree trunks, resulting in tree damage which leads to reduced production. Management techniques can control this problem.)

The factors and weights given them for red tart cherry sites are shown on the Fruit Site Rating Sheet.

1/ See Appendix for definition

FRUIT SITE RATING SHEET

I. Soil Factors

	Rating Value	Actual Score
A. Texture: 1/ Possible Score = (40)		
Sandy (Sands)	10	
(Loamy Sands)	20	
Coarse loamy	40	
Fine loamy	30	
Clayey	10	
Clayey (very fine)	5	
Organic	0	
B. Drainage: Possible Score = (40)		
Well drained	40	
Moderately well drained	30	
Somewhat poorly drained	20	
Poorly and very poorly drained	10	
C. Restrictions to Rooting: Possible Score = (20)		
No restrictions to 48 inches	20	
Coarse fragments within 48 inches	10	
Pans within 48 inches	5	

(Total possible score = 100) I. Total Actual Score _____

II. Physiographic Factors

A. Slope: Possible Score = (35)		
2-12%	35	
0-2%	30	
12-18%	15	
Over 18% (Unsuitable for mechanical harvest)	10	
B. Elevation above Principal Spring Freeze Line: Possible Score = (30)		
100 feet +	30	
50-100 feet	25	
20-50 feet	20	
Less than 20 feet	0	
C. Air Drainage: Possible Score = (35)		
Uninterrupted airflow to major air storage basin	35	
Minor obstruction to air flow to major air storage basin	25	
Major obstruction to air flow to air storage basin	5	

(Total possible score = 100) II. Total Actual Score _____

1/ Refers to soil family texture as used in the Soil Classification System of the National Cooperative Soil Survey.

FRUIT SITE RATING SHEET (cont'd)

III. Climatic Factors

	Rating Value	Actual Score
A. Spring Temperatures: Possible Score = (70)		
Probability of damaging freeze or cold weather during fruit set during 10-year period.		
(2 in 10)	70	
(3-4 in 10)	40	
(5-6 in 10)	10	
B. Winter Temperatures: Possible Score = (30)		
Probability of extreme cold winter temperature during 10-year period.		
(2 in 10)	30	
(3-4 in 10)	5	
(5-6 in 10)	0	

(Total possible score = 100) III. Total Actual Score _____

(The occurrence of fog, wind, and hail were not given individual ratings, however, they were included in the overall site evaluation.)

Summary of Scores - Section I _____
" II _____
" III _____

Site Rating or Total Score _____

Interpretation of Fruit Site Ratings

Total Score	Map Color	Difficulty of Overcoming Limitations to Production
300-290	Green	Slight
285-225	Yellow	Moderate
220-170	Red	Severe
165 or less	No Color	Very Severe

Following onsite examination and scoring of each item in the rating sheet, the total score for a site is obtained by adding the sums of the rating scores for the soil, physiographic, and climatic factors. This total is referred to as Fruit Site Rating.

Map Preparation

Colors and symbols are used to identify and to delineate fruit sites. The ranges (interval) of fruit site ratings used in the red tart cherry site inventory in Leelanau County are shown with map colors and degree of limitation on the bottom of the Fruit Site Rating Sheet.

Explanation of Colors

GREEN

The areas colored green on the map are within the narrow range of 290 to 300. These represent the most desirable red tart cherry sites. The major soils are well drained, moderately coarse textured and have no restricted root zone within 48 inches of the surface. The slopes range ideally from 2 to 12 percent. The elevation above the principal spring freeze line is over 50 feet. Air flow is unimpeded or is blocked only by minor obstructions that can be easily removed. The probability of damaging freeze or cold weather during the time of fruit set is 2 years or less in 10 years. The probability of extreme cold winter temperatures is 2 years or less in 10 years. The soils, physiographic features and microclimate individually and collectively create few limitations to production.

YELLOW

Areas colored yellow on the map have a range of 225 to 285. They are good tart cherry producers but need intensive management practices to overcome the moderate limitations to production. One to three of the following factors may cause the lowered site rating:

1. Low available water capacity.
2. Low natural fertility.
3. In some locations, a water table within 4 or 5 feet of the surface.
4. Slopes somewhat steeper than 12 percent.
5. Elevations less than 50 feet, but over 20 feet above the principal spring freeze line.

The probability of damaging freeze, cold weather, or fog during blossom time or the probability of extremely low winter temperatures is not more than 3 to 4 years in 10 years.

Other features that may depress the rating are: areas needing random drainage; areas of nearly level land within dish-shaped terrain in which cold air is likely to stagnate; blockages that stop air movement; or small areas that are adversely affected because of very coarse or fine textured soil inclusions. Symbols are used to indicate these features on the map.

RED

Areas colored red have a range from 170 to 220. The severe limitations are difficult to overcome by management. All limitations should be considered carefully before planning to plant these areas to red tart cherries.

Where small areas of this range occur within areas with fewer limitations, it may be feasible to consider corrective measures. One limiting factor of sufficient severity which cannot be corrected will suffice to rate a site between 170 - 220. Adverse characteristics are:

1. Low available water capacity.
2. Low natural fertility.
3. Moderately slow permeability.
4. Slopes that cause difficulty in efficient machinery operation.
5. Elevations near or at the principal spring freeze line with a probability of a freeze of 4 to 5 years in 10 years or extreme low temperature of 4 to 5 years in 10 years.
6. Major obstruction to air flow.

UNCOLORED

Areas having a rating of 165 or below are uncolored on the map. The limitations are so severe that these areas are not considered as red tart cherry sites.

The principal limiting factors are:

1. Poorly drained soils.
2. Extremely droughty, infertile soils.
3. Slopes that are too steep for orchard equipment operation.
4. Large areas having little or no air drainage.
5. Location below the principal spring freeze line with a frequency of 6 or more of 10 years of spring freeze and the same probability of extreme low winter temperatures.
6. Areas subject to frequent occurence of fog during blossom period.

INTERPRETATION OF THE MAP

In arriving at a fruit site rating, it is assumed that modern soil and orchard management practices are to be applied. Special efforts are made not to be influenced in a site evaluation of a particular parcel by effects of either a substantially higher or lower level of management than is the norm on a producing orchard now occupying such a site. It is realized that improvements in management practices will continue to affect production in the future, but they are not likely to change a site rating.

Modification of Hazards

Available weather data is useful in broad determinations of whether or not certain crops can be considered for an area. The microclimate influences that affect fruit set cannot be obtained from existing weather data.

The site rating was made on the basis of the "natural characteristics" of the site and not for the possibility of using artificial heating for freeze protection. The need for additional microweather information is recognized. Such information would permit refinement in estimating the size of cold air storage basins in relation to drainage areas. The fruit site inventory was developed by today's standards of plant selection for red tart cherry planting stock. It does not rule out the possibility of improved varieties through a plant selection program that may reduce the site requirements of today's planting stock. The use and interpretations of the site map will not eliminate the need for onsite study and investigation for individual tracts.

Colors used on the map indicate the relative degree of hazard that exists for producing red tart cherries. Some of these hazards can be controlled. Also, some sites colored yellow or red may be as productive as the green colored sites if the limiting factors are corrected.

A minor air flow block may be removed by opening up wooded areas or even by removing undergrowth. Small ridges of earth may be flattened with little effort. A major block to air flow such as a large earth obstruction can require major engineering to remove. This may be advisable if the cost-return ratio is favorable.

Areas with favorable air drainage but too steep for orchard operations may be reclaimed by reshaping the slopes. Where steep slopes are remade to more gentle slopes to accommodate mechanized operations, problems of severe erosion, rapid runoff, reduced aeration and unbalanced plant nutrition in the exposed subsoil material can result. Very intensive soil management may be needed to overcome these difficulties.

Sites rated low because of low available water capacity may be made productive with irrigation and intensive fertilization. Small wet spots may be drained, but tile drainage of orchards sometimes require increased maintenance because of clogging by fruit tree roots.

Advantage should be taken of land forms to minimize cold weather damage before introducing artificial heat.

HOW TO USE THE RED TART CHERRY SITE INVENTORY

Locating Areas

At the back of this report is an index map and the red tart cherry site inventory map consisting of many sheets. On the index map are rectangles numbered to correspond to the sheets of the site map so that the map for any area can be located easily. On each map the site boundaries are outlined. Ad hoc symbols appearing within site boundaries are explained in the legend sheet. Small islands of desirable red tart cherry sites may occur in the unmapped area. Generally, they are too small in size to be considered for commercial orchards.

Finding Information

Explanation of colors used, page 5.

Definition of terms used are given in the appendix.

Explanation of symbols given in legend, on back of Index to Maps.

Soil information for Leelanau County is available on request from the Soil Conservation Service Field Office in Lake Leelanau, Michigan.

For selected readings on climate, refer to references given in the appendix.

APPENDIX

To aid understanding and insure uniform interpretation, definitions or explanations are given here for some of the terms used in this report.

Conditions affecting the microclimate of a particular site can increase or decrease the hazard of frost, fog or other localized climate important to the production of fruit or other very sensitive crops. The following is an attempt to define items that must be recognized in evaluating fruit sites. These are things which the experienced grower unconsciously considers when looking at a potential orchard site. By experience these items have been found to influence success or failure of orchards on various sites over many years.

Air Flowageway

This is assumed to be the same flowageway as used by water except that it may be modified by physical conditions that affect air movement but that may not hinder water flow.

Air Movement

The movement of air under calm (no wind) conditions is due to changes in temperatures of the air. Warm air moves upward because it is less dense (lighter) and when moving upward it expands and cools. Cooling causes the air to become more dense, making it descend. This movement by convection is a principle which orchardists attempt to use and manipulate to their advantage. Unlike water, air moving down a slope tends to pile up behind a barrier and may build up to several times the height of the barrier before flowing over it and on downslope. It is suggested that this buildup may be caused by the leading edge being forced upward as it mixes with upward-moving air warmed by radiation from the top of the barrier. Surface drag caused by resistance to air flow over ground vegetation also influences the downward flow of colder air. Observations indicate that movement of air down an air flowageway is not at a steady rate but tends to surge, then slow, then surge ahead again.

Airshed

For this application it can be assumed that the airshed will be the same area as a watershed contributing to a common outlet or storage basin.

Air Storage Over Water

Air flowageways ending over water are more desirable than those ending over land. Water, having better heat conductivity and greater heat storage than soil, warms the incoming cold air in contact with it causing that air to rise, thus making room for more cold air entering from the flowageway.

Coarse Fragments

Rock or mineral particles greater than 2.0 millimeters in diameter.

Fog Damage

This refers to periods of daytime fog that inhibit the pollination of blossoms or that can cause delay in application of sprays for control of diseases. These conditions may occur in small pockets or they may be common to larger areas that are subject to marine influence.

Major Obstruction

A closed barrier or constriction in an air flowageway which will require large expenditures of time and money to correct is considered a major obstruction. Examples are: raised roadbed or buildings constructed across an air flowageway; or large earth ridges or even conifer swamps which slow cold air movement to lower elevations.

Minor Obstruction

A minor obstruction is a constriction of air flowageway which can be readily removed at relatively small cost. Examples are: trees or small earth ridges which impede air movement to lower elevations.

Microclimate

This refers to the climate of an area, usually small, over which weather conditions are substantially the same. Differences of soil, soil cover, elevation and other factors can be responsible for significant variation in microclimate in areas only a few yards to a few hundred feet apart.

Pan

Horizon or layer in soils that is strongly compacted, indurated, or very high in clay content.

Principal Spring Freeze Line

The principal spring freeze line is a locally determined elevation line which separates favorable from unfavorable spring temperatures for red tart cherry production. The frequency or severity of loss decreases with an increase of elevation above the principal spring freeze line.

Soil Drainage

As a natural condition of the soil, soil drainage refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil.

Spring Damage

This refers to partial or complete kill of fruit due to below freezing temperatures occurring from the time of spring bud swell to 14 to 18 days after bloom. It may also include poor pollination and fruit set because of cloudy days, rain or fog during blossom time.

Storage Basin

The lowest area to which air drains of its own free flow.

Minor Storage Basin

The area in which air may be held until sufficient fill takes place for overspillage to a major basin.

Size of Storage Basin

No definite criteria are available to say how large a storage basin should be for a definite drainage area. The larger the drainage area, the greater the size of the storage basin needed. It should be of sufficient size to permit the storage of cold air until daylight hours and accompanying warming.

Winter Temperature Injury

This refers to injury to fruiting buds and wood caused by temperature extremes or rapid fluctuation.

1. Wood injury associated with immaturity - early winter.

2. Injury associated with drought (long periods of extremely cold air) - midwinter.

3. Injury to wood and bark due to an extremely fast drop in temperature (moderate winter temperature to very frigid temperature) - midwinter.

4. Injuries characteristic of late winter conditions.

Injuries such as trunk splitting that cause major damage to the structure of a tree received a zero rating for red tart cherries.

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USDA-SCS-LINCOLN, NEBR. 1973

5,L-32,169

INDEX TO MAP SHEETS
LEELANAU COUNTY, MICHIGAN

Scale 1: 200,000

1 0 1 2 3 4 Miles

N

R. 14 W.
T. 32 N.
3
Lake Manitou
North Manitou
31
6
4
5
NORTH MANITOU ISLAND
TO LELAND TOWNSHIP
T. 31 N.
R. 15 W.
6
SOUTH MANITOU ISLAND
Florence Lake
T. 30 N.
TO GLEN ARBOR TOWNSHIP
86°10′

45°30′
R. 13 W.
1
NORTH FOX ISLAND
TO LEELANAU TOWNSHIP
85°45′
2
T. 35 N.
31
6
45°25′
T. 34 N.
SOUTH FOX ISLAND
85°50′

R. 11 W.
R. 10 W.
Lighthouse Point
Cathead Point
7
6
201
T. 32 N.
Mud Lake
45°10′
MICHIGAN
8
9
TRAVERSE
Northport
Northport Point
22
10
Northport Bay
11
Ents Cr.
GRAND
T. 31 N.
LAKE
LEELANAU
R. 12 W.
12
13
Bass Lake
Omena
14
36 31
1 6
Bellows Cr.
LAKE
LELAND
15
Peshawbestown
SUTTONS BAY
16
LEELANAU
45°00′
T. 30 N.
204
Suttons Point
Lake Leelanau
Suttons Bay
17
18
LELAND
Suttons Bay
BAY
19
R. 13 W.
Good Harbor Bay
Shell Lake
Little Traverse L.
Bass Lake
School Lake
20
21
22
23
BINGHAM
24
OHIO
Keswick
Lee Point
TRAVERSE
T. 29 N.
R. 14 W.
Glen Haven
GLEN ARBOR
109
Glen Arbor
25
26
27
CLEVELAND
Lime Lake
CENTERVILLE
28
29
AND
Bingham
GRAND
GLEN LAKE
LAKE
Maple City
Cedar
Victoria Cr.
LEELANAU
30
31
32
33
34
CHESAPEAKE
ARM
44°50′
KASSON
T. 28 N.
Empire
72
Rush Cr.
Cedar
WEST
35
EMPIRE
36
37
38
SOLON
39
Greilickville
ELMWOOD
BENZIE COUNTY
86°00′
85°50′
GRAND TRAVERSE CO.
85°40′

LEELANAU COUNTY, MICHIGAN

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads

Good motor

Poor motor

Highway markers

U. S.

State or county

Railroads

Single track

Bridges and crossings

Road

Railroad

Mine and quarry

Gravel pit

Forest fire or lookout station

Lighthouse

Cemetery

Dams

RELIEF

Escarpments

Bedrock

Other

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		

Gravel

Stoniness

Rock outcrops

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Severely eroded spot

Blowout, wind erosion

Gully

Borrow pit

B.P.

Short steep slope

BOUNDARIES

County

Minor civil division

Reservation

Small park, cemetery, airport

Land survey division corners

DRAINAGE

Streams, double-line

Perennial

Intermittent

Streams, single-line

Perennial

Intermittent

Crossable with tillage implements

Not crossable with tillage implements

Lakes and ponds

Perennial

water

w

Intermittent

int

Spring

Marsh or swamp

Wet spot

Drainage end

AD HOC SYMBOLS

Physiographic features cause lower temperatures during critical blossom period

Concave surface causing slow air movement

Major block to downward air movement

Soils with special limitations

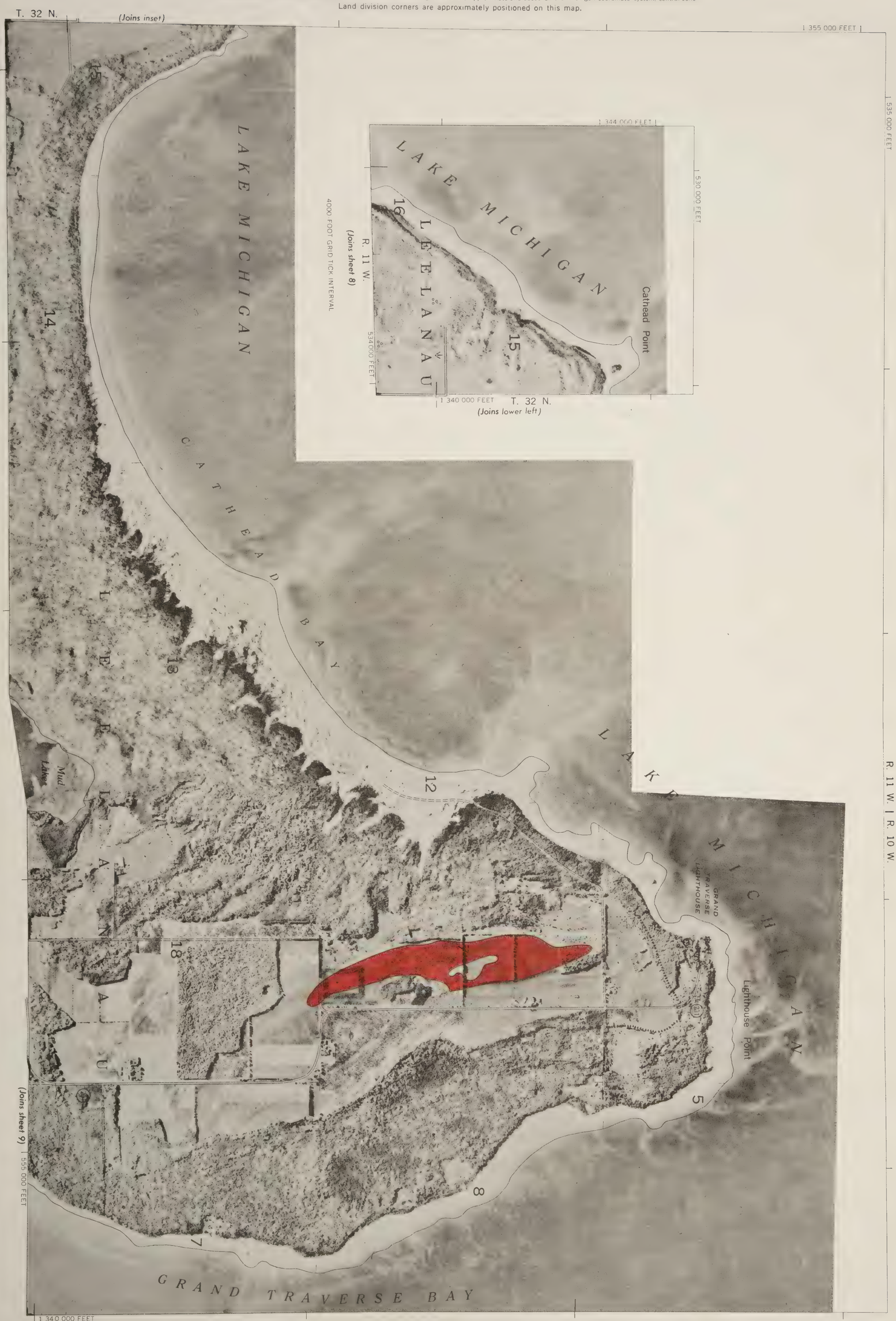
Topographic features with many depressions that collect and hold cold air. Also known as pitted topography or kettles.

K

INTERPRETATIONS FOR FRUIT SITE RATING

TOTAL SCORE	MAP COLOR	DIFFICULTY OF OVERCOMING OF LIMITATIONS TO PRODUCTION
300 - 290		SLIGHT
285 - 255		MODERATE
220 - 170		SEVERE
165 OR LESS		VERY SEVERE

Photobase from 1965 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Michigan coordinate system, central zone
Land division corners are approximately positioned on this map.



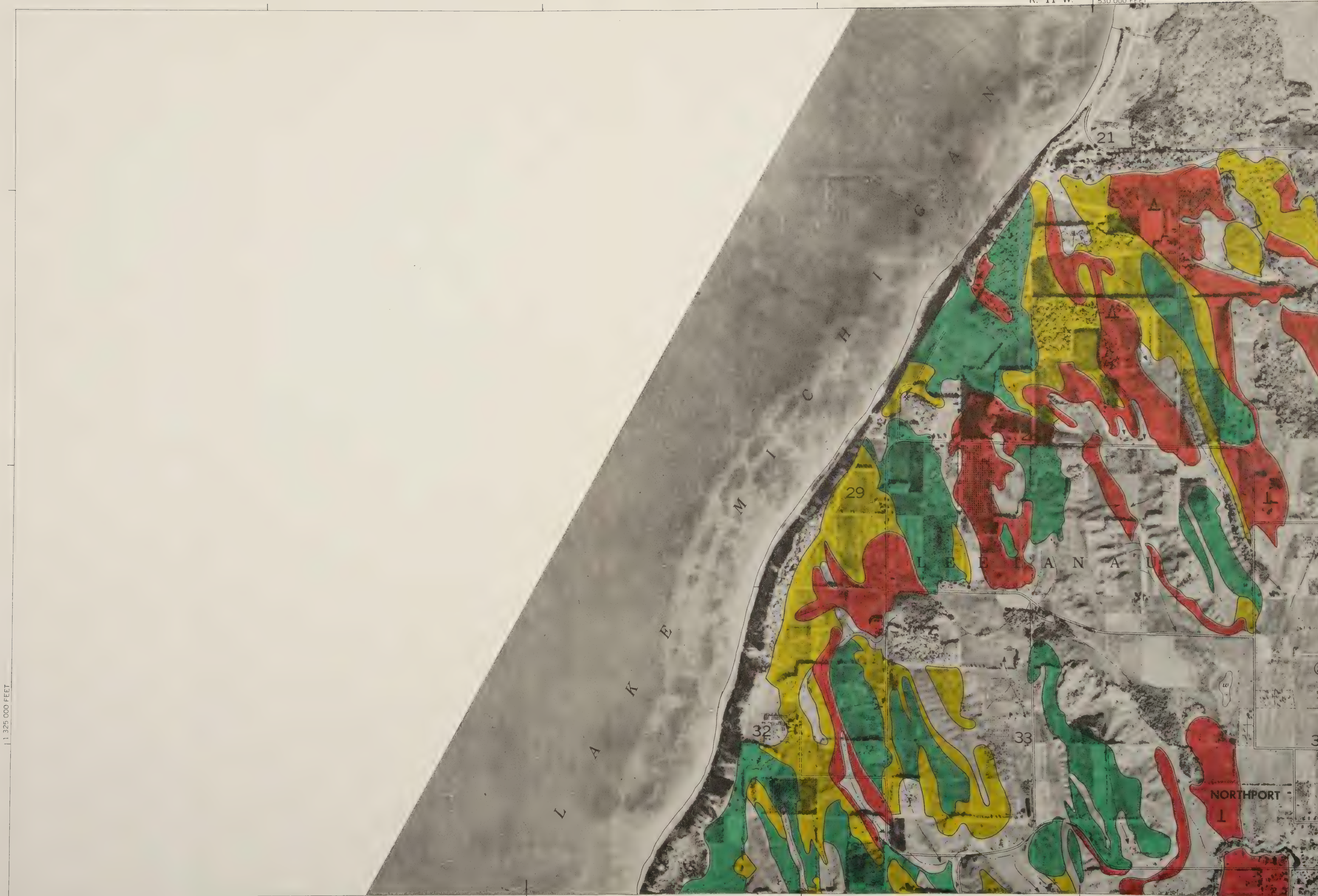
LEELANAU COUNTY,
MICHIGAN NO. 7

1 ¾ ½ ¼ 0 1 Mile

5000 4000 3000 2000 1000 0 5000 Feet

Scale 1:20000

N



N

1 Mile
5000 Feet
Scale 1:20000
0 ¼ ½ ¾ 1
0 1000 2000 3000 4000 5000

LEELANAU COUNTY, MICHIGAN NO. 8

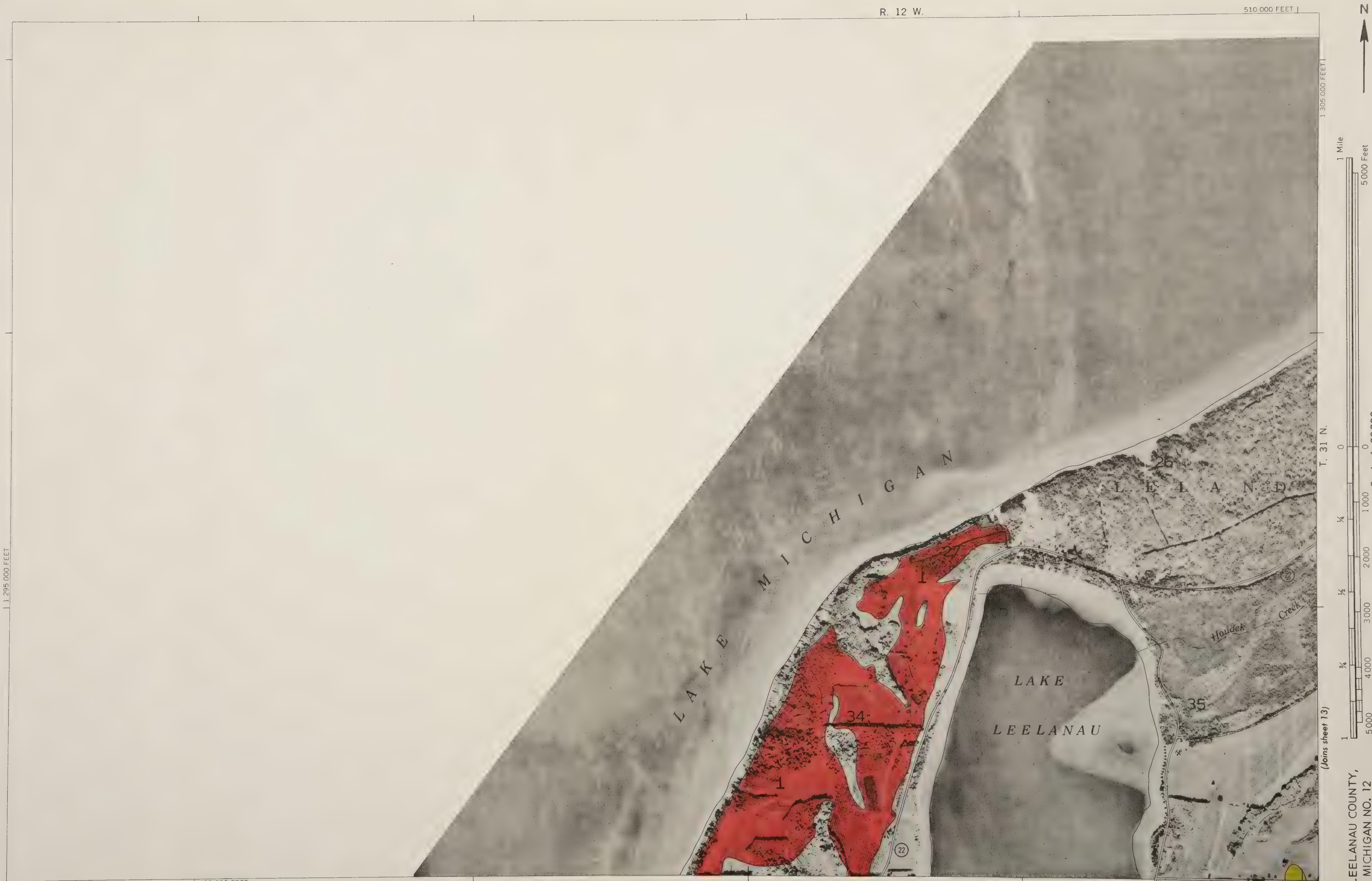

(Joins sheet 8)
T. 32 N.
1 335 000 FEET
(Joins 11)
NORTHPORT
34
35
27
26
22
23
24
25
36
31
Lee Lake
LEELANAU
NORTHPORT BAY
Paradesia Point
Bay
WOOLSEY LANDING FIELD
Mud Lake
R. 11 W.
R. 10 W.
Northport Point
GRAND TRAVERSE BAY
(Joins sheet 7)
1 325 000 FEET
LEELANAU COUNTY, MICHIGAN NO. 9
1 Mile
5000 Feet
Scale 1:20000
N

N

1 Mile · 5000 Feet
Scale 1:20000

LEELANAU COUNTY,
MICHIGAN NO. 10

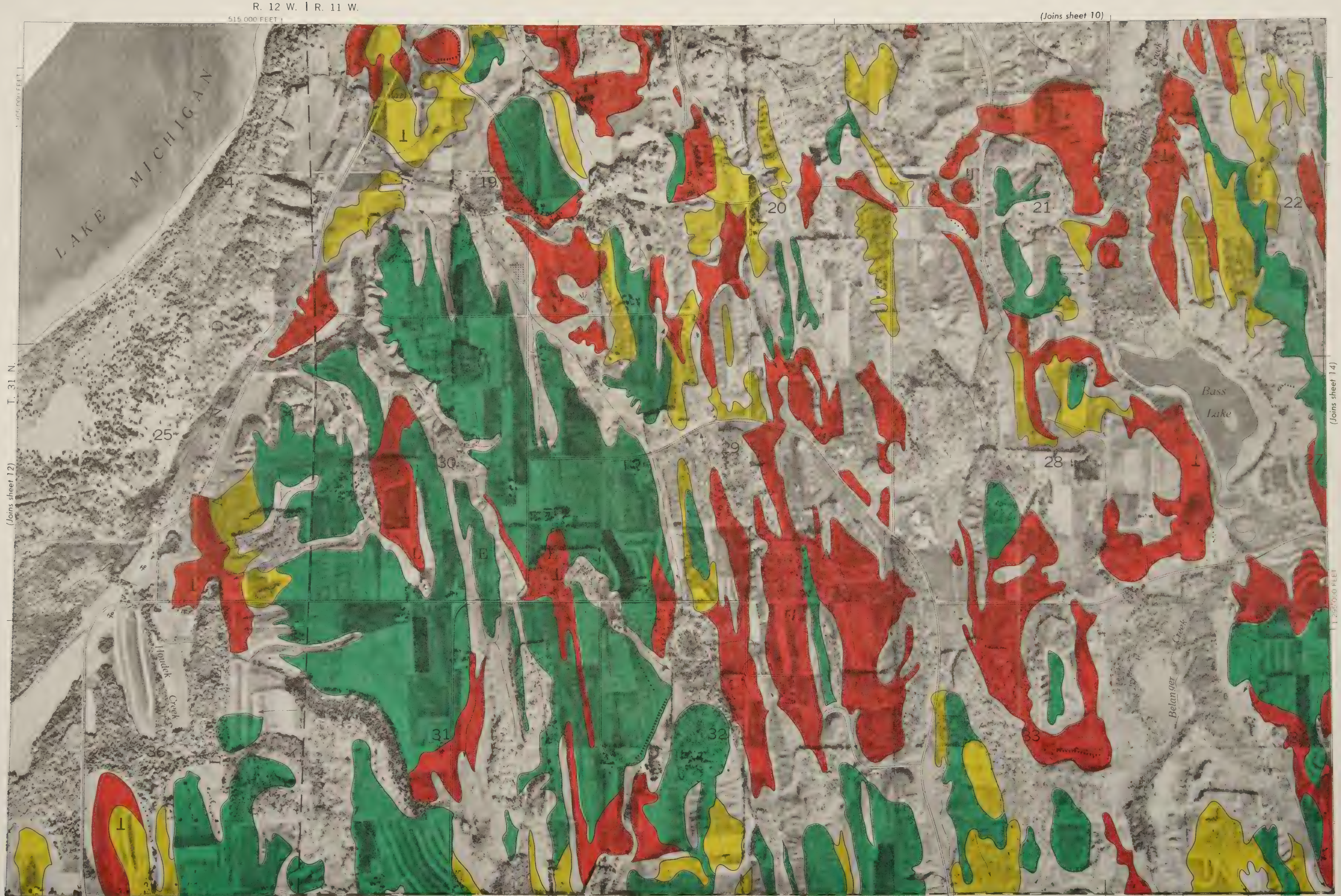

(Joins sheet 8)
(9)
535 000 FEET
R. 11 W.
NORTHPORT
T. 31 N.
(Joins sheet 10)
(Joins sheet 14)
GRAND TRAVERSE BAY
NORTHPORT BAY
LEELANAU
Bellow Island
CHESAPEAKE AND OHIO
3
11
14
15
555 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
LEELANAU COUNTY, MICHIGAN NO. 11



(Joins sheet 13)

(Joins sheet 15) | (Joins sheet 16)

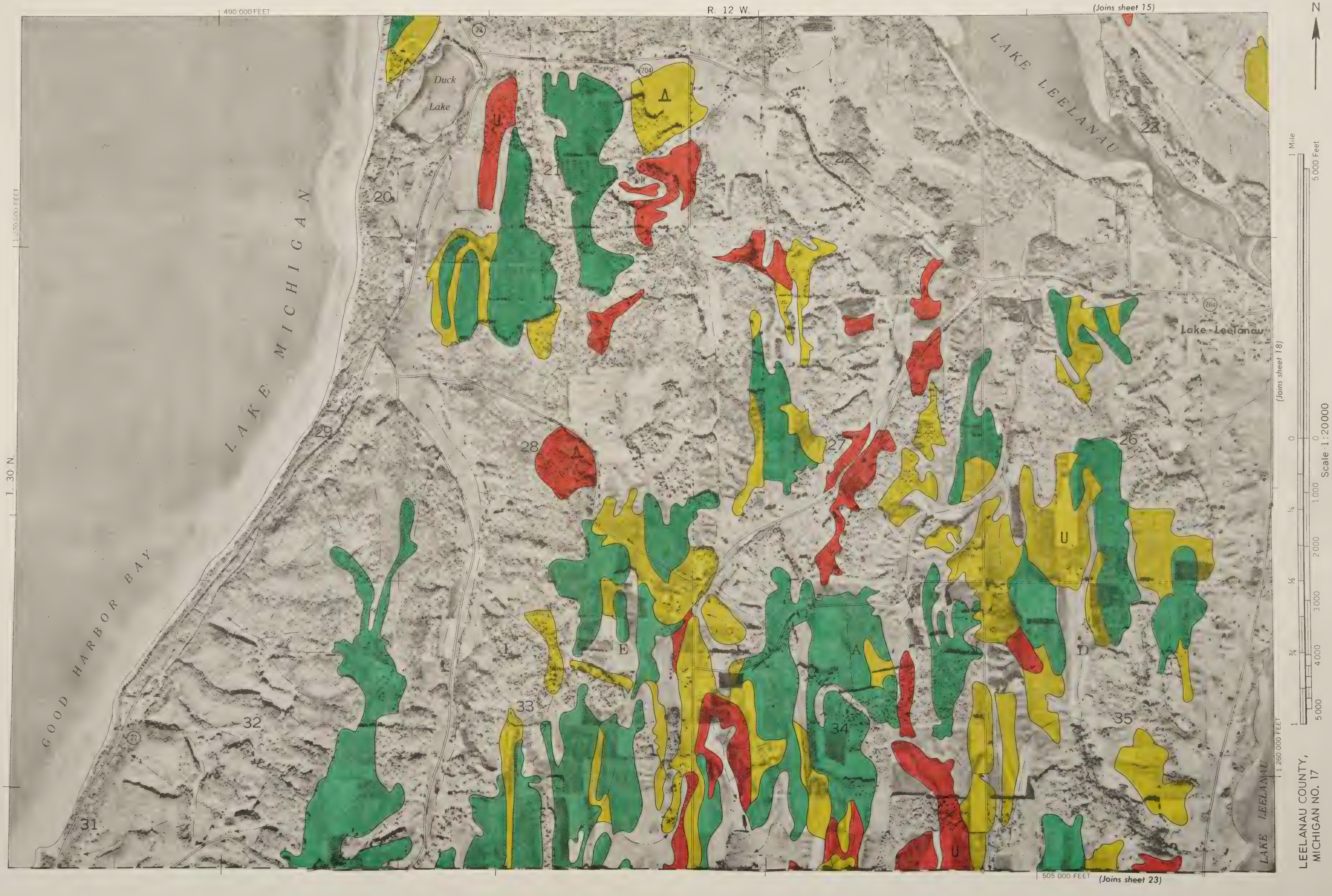
LEELANAU COUNTY, MICHIGAN NO. 12


R. 12 W. | R. 11 W.
515 000 FEET
(Joins sheet 10)
N
LAKE MICHIGAN
T. 31 N.
(Joins sheet 12)
(Joins sheet 14)
Bass Lake
Belanger Creek
Houdek Creek
19
20
21
22
24
25
28
29
30
31
32
33
36
(Joins sheet 16) | (Joins inset, sheet 14)
1 Mile
5000 Feet
Scale 1:20000
LEELANAU COUNTY, MICHIGAN NO. 13

LEELANAU COUNTY, MICHIGAN NO. 14

LEELANAU COUNTY, MICHIGAN NO. 15

(Joins 12)
(Joins sheet 13)
R. 12 W.
R. 11 W.
530 000 FEET
1 290 000 FEET
N
(Joins sheet 15)
(Joins inset, sheet 14)
T. 30 N.
1 275 000 FEET
510 000 FEET
(Joins sheet 18)
SUTTONS BAY
water
1 Mile
5000 Feet
Scale 1:20000
LEELANAU COUNTY, MICHIGAN NO. 16



LEELANAU COUNTY, MICHIGAN NO. 17

LEELANAU COUNTY, MICHIGAN NO. 18

LEELANAU COUNTY, MICHIGAN NO. 19

1 ¾ ½ ¼ 0 1 Mile

5000 4000 3000 2000 1000 0 5000 Feet

Scale 1:20000

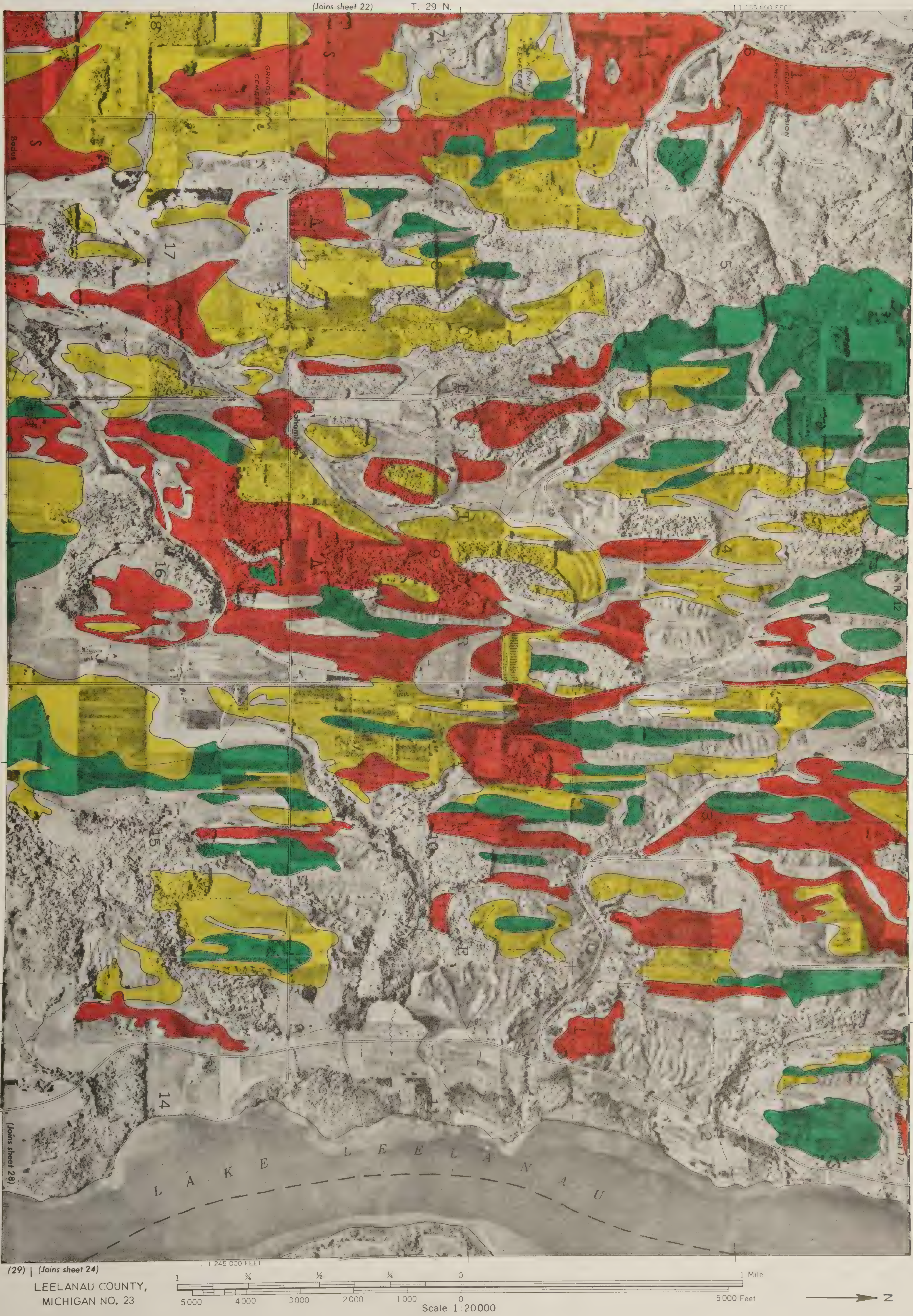
N

435 000 FEET
460 000 FEET
1 265 000 FEET
1 255 000 FEET
1 620 000 FEET
1 245 000 FEET
450 000 FEET
415 000 FEET
Pyramid Point
Hidden Lake
LAKE MICHIGAN
CLEVELAND
GLEN ARBOR
36
31
32
33
T. 30 N.
T. 29 N.
R. 14 W.
R. 13 W.
(Joins sheet 21)
(Joins sheet 22)
Sleeping Bear Point
SLEEPING BEAR BAY
18
17
24
(Joins sheet 25)
R. 15 W.
R. 14 W.
N
1 Mile
5000 Feet
Scale 1:20000
LEELANAU COUNTY, MICHIGAN NO. 20

LEELANAU COUNTY,
MICHIGAN NO. 21

Scale 1:20000

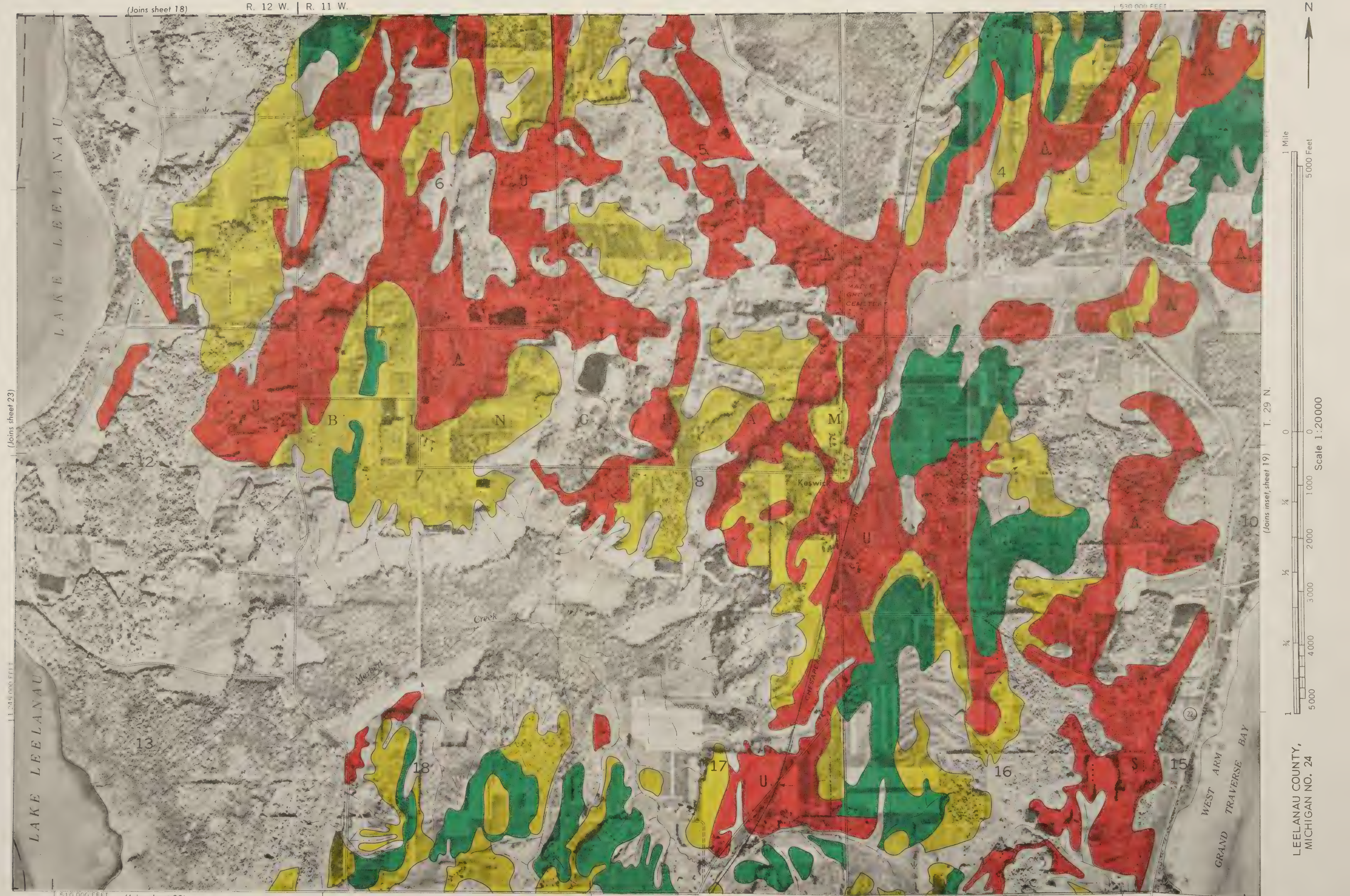
LEELANAU COUNTY, MICHIGAN NO. 22



(29) | (Joins sheet 24)

LEELANAU COUNTY,
MICHIGAN NO. 23

Scale 1:20000



(Joins sheet 18)
R. 12 W. | R. 11 W.
530 000 FEET
N
LAKE LEELANAU
B I N G H A M
6
5
4
7
8
Keswick
10
T. 29 N.
Creek
13
18
17
16
15
WEST ARM GRAND TRAVERSE BAY
(Joins sheet 23)
(Joins inset, sheet 19)
516 000 FEET
(Joins sheet 29)
1 Mile
5000 Feet
Scale 1:20000
LEELANAU COUNTY, MICHIGAN NO. 24

415 000 FEET

R. 15 W. | R. 14 W.

(Joins sheet 20)

LAKE MICHIGAN

LAKE MICHIGAN

SLEEPING BEAR BAY

Glen Haven

Glen Arbor

Devils Hole

SLEEPING BEAR DUNES

GLEN ARBOR

GLEN LAKE

GLEN LAKE

19

20

21

22

24

25

27

28

29

30

31

32

33

34

36

209

109

22

N

T. 29 N.

1 Mile

5000 Feet

0

0

1000

Scale 1:20000

(Joins sheet 26)

¼

½

¾

1

2000

3000

4000

5000

LEELENAU COUNTY,
MICHIGAN NO. 25

(Joins sheet 30)

435 000 FEET


(Joins sheet 21)
R. 14 W. | R. 13 W.
460 000 FEET
N
1 240 000 FEET
LAKE MICHIGAN
SLEEPING BEAR BAY
Glen Arbor
G L E N A R B O R
Fisher Lake
Brooks Lake
G L E N L A K E
C L E V E L A N D
22
23
24
19
20
26
25
27
30
29
36
31
32
(Joins sheet 25)
(Joins sheet 27)
1 230 000 FEET
440 000 FEET
(Joins sheet 31)
Scale 1:20000
1 Mile
5000 Feet
LEELANAU COUNTY, MICHIGAN NO. 26

LEELANAU COUNTY, MICHIGAN NO. 27

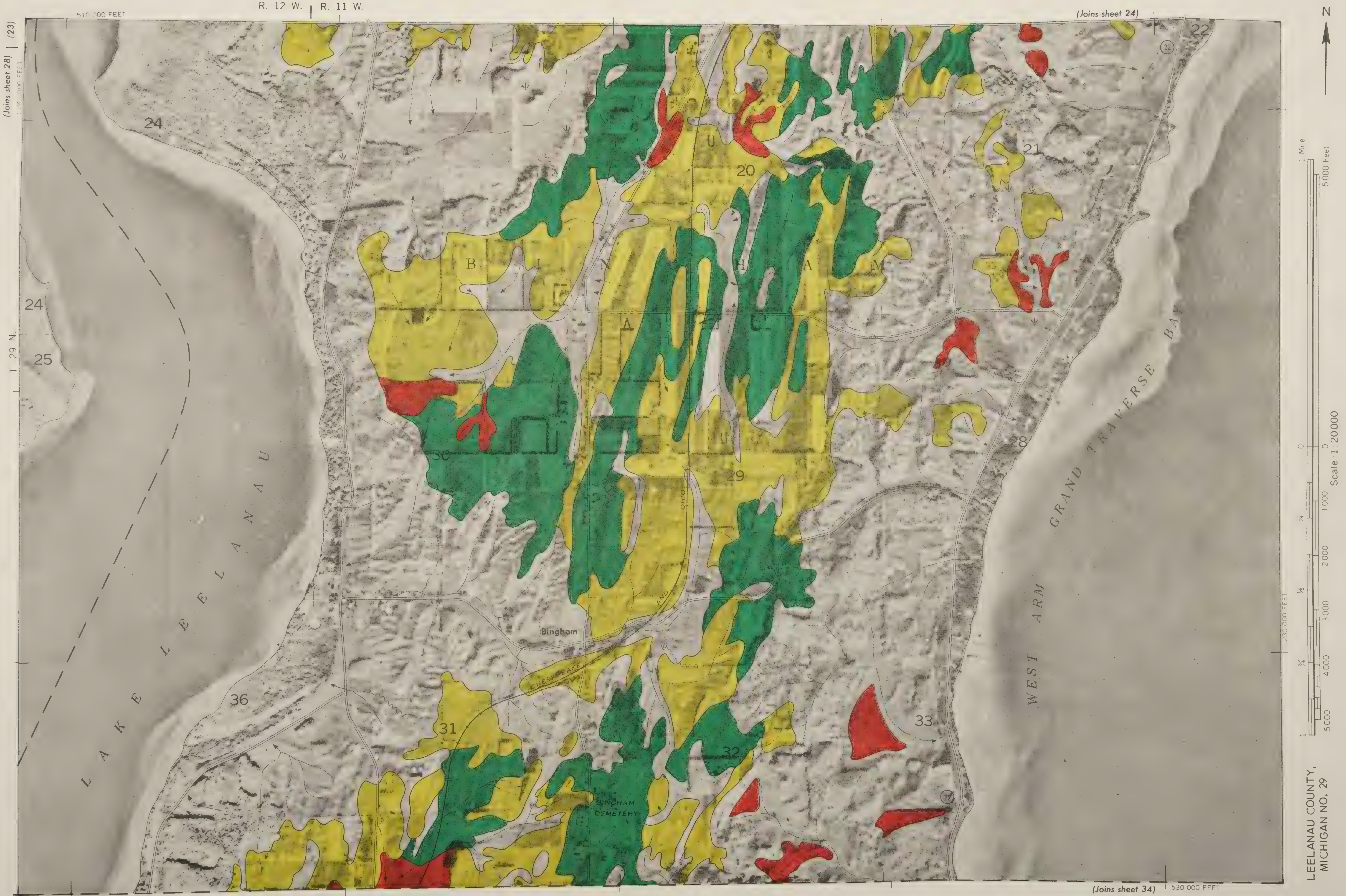
LEELANAU COUNTY, MICHIGAN NO. 28

1 ¾ ½ ¼ 0 1 Mile

5000 4000 3000 2000 1000 0 5000 Feet

Scale 1:20000

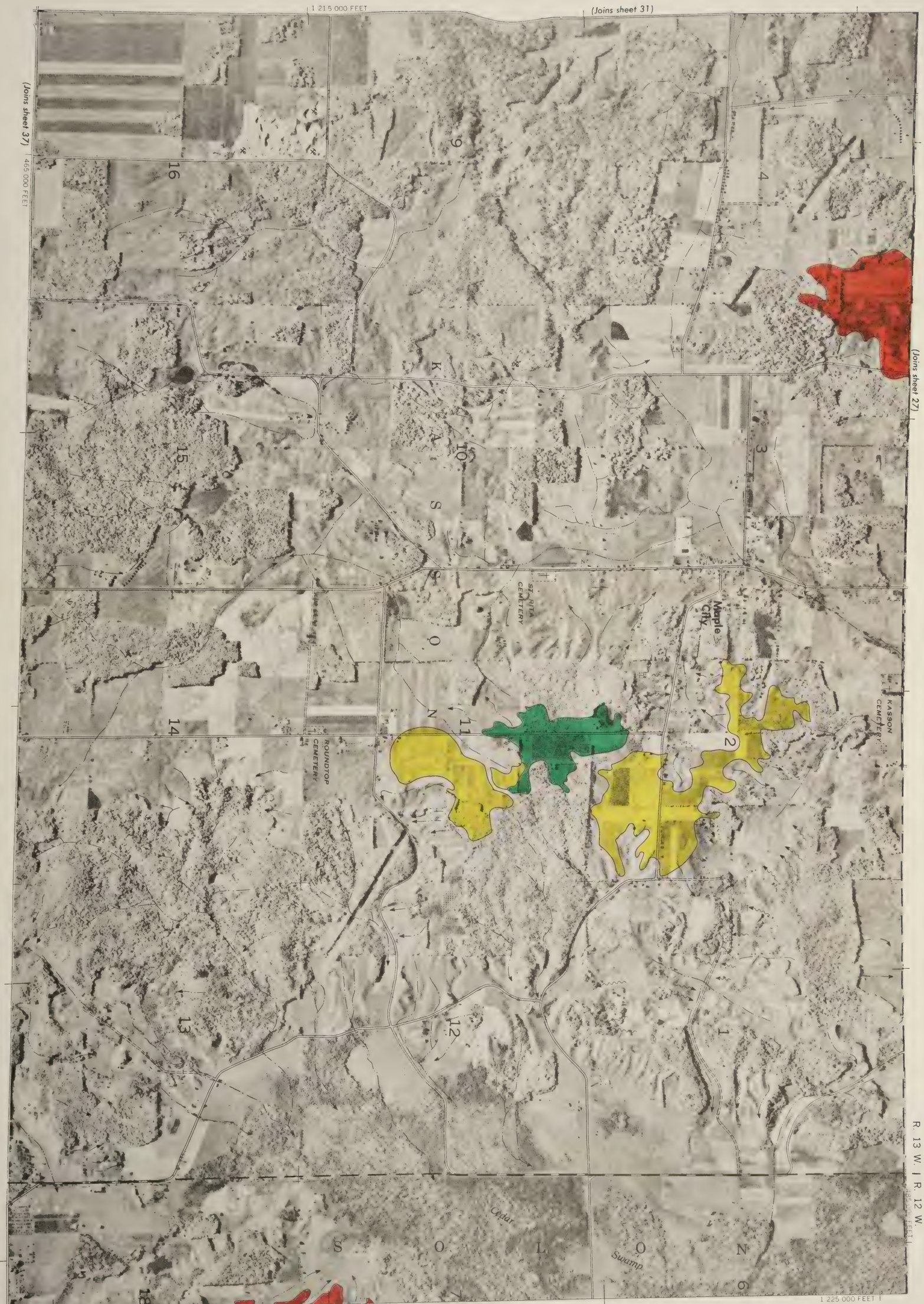
N



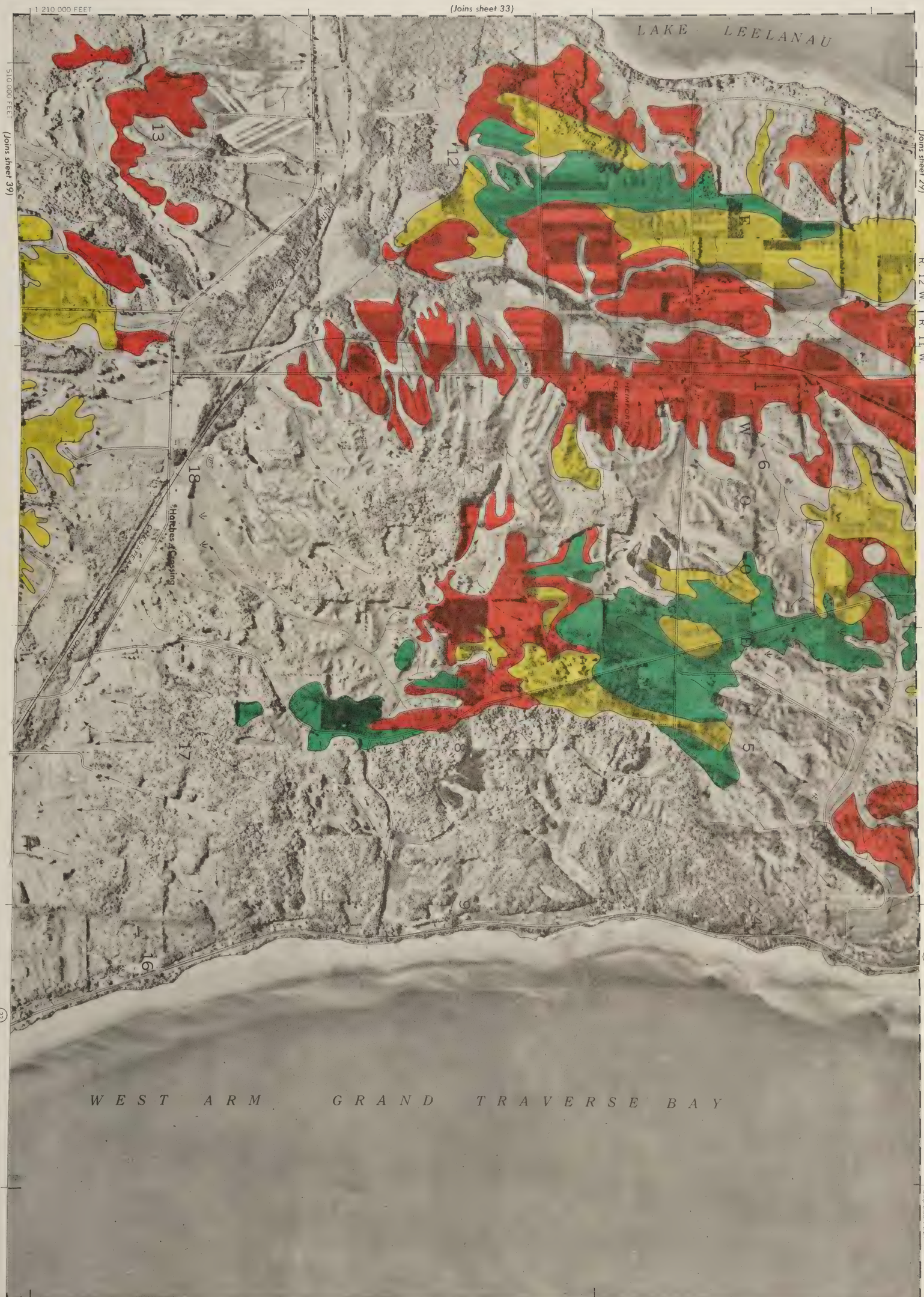
510 000 FEET
R. 12 W.
R. 11 W.
(Joins sheet 24)
(Joins sheet 28)
(23)
1 240 000 FEET
24
24
25
T. 29 N.
20
21
22
B I N G H A M
U
U
30
29
28
LAKE LEELANAU
WEST ARM GRAND TRAVERSE BAY
CHESAPEAKE AND OHIO
Bingham
BINGHAM CEMETERY
36
31
32
33
(Joins sheet 34)
530 000 FEET
1 230 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
LEELANAU COUNTY, MICHIGAN NO. 29

LEELANAU COUNTY, MICHIGAN NO. 30

LEELANAU COUNTY, MICHIGAN NO. 31


1 215 000 FEET
(Joins sheet 31)
(Joins sheet 37)
465 000 FEET
(Joins sheet 27)
16
9
4
15
10
3
14
11
2
13
12
1
18
K A S S O N
S O L O N
St. Rita Cemetery
Maple City
Kasson Cemetery
Roundtop Cemetery
Cedar Swamp
(Joins sheet 33)
T. 28 N.
1 225 000 FEET
R. 13 W. | R. 12 W.
LEELANAU COUNTY, MICHIGAN NO. 32
1 ¾ ½ ¼ 0 1 Mile
5000 4000 3000 2000 1000 0 5000 Feet
Scale 1:20000
N

LEELANAU COUNTY, MICHIGAN NO. 33


1 210 000 FEET
(Joins sheet 33)
LAKE LEELANAU
510 000 FEET
(Joins sheet 39)
(Joins sheet 29)
R. 12 W.
R. 11 W.
T. 28 N.
1 225 000 FEET
530 000 FEET
Holbes Crossing
CEMETERY
HEIMFORTH
WEST ARM GRAND TRAVERSE BAY
LEELANAU COUNTY, MICHIGAN NO. 34
1 Mile
5000 Feet
Scale 1:20000
N

LEELANAU COUNTY, MICHIGAN NO. 35

1 ¾ ½ ¼ 0 1 Mile

5000 4000 3000 2000 1000 0 5000 Feet

Scale 1:20000

N

LEELANAU COUNTY,
MICHIGAN NO. 36

465 000 FEET

1 210 000 FEET

(Joins sheet 32)

R. 13 W. | R. 12 W.

N

Bright Lake

21

22

23

24

19

EAST KASSON CEMETERY

28

27

26

25

30

(Joins sheet 38)

(Joins sheet 36)

K A S S O N

FIFE LAKE STATE FOREST

33

34

35

36

31

WILSON CEMETERY

Davis Lake

Hart Lake

1 195 000 FEET

BENZIE COUNTY

485 000 FEET

GRAND TRAVERSE COUNTY

1 Mile

5000 Feet

Scale 1:20000

LEELANAU COUNTY, MICHIGAN NO. 37

LEELANAU COUNTY, MICHIGAN NO. 38

R. 12 W. | R. 11 W.

510 000 FEET

(22)

(Joins sheet 34)

N

T. 28 N.

1 205 000 FEET

(Joins sheet 38)

24 19 20 21

C E D A R L A K E

E L M W O O D

29 30 28

CHESAPEAKE AND OHIO

31 32 33

GREILICKVILLE

36

W E S T A R M G R A N D T R A V E R S E B A Y

1 195 000 FEET

530 000 FEET

GRAND TRAVERSE COUNTY

1 Mile

5000 Feet

Scale 1:20000

LEELANAU COUNTY,
MICHIGAN NO. 39